United States Patent

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[73] Assignee **Sylvania Electric Products, Inc.**

[54] **METHOD OF MAKING A HERMETICALLY SEALED CIRCUIT BREAKER**
7 Claims, 7 Drawing Figs.

[52] **U.S. Cl.** **29/624,** 337/372
[51] **Int. Cl.** **H01h 11/00**
[50] **Field of Search** 29/622, 627, 624; 337/372, 380, 363, 368, 343, 347

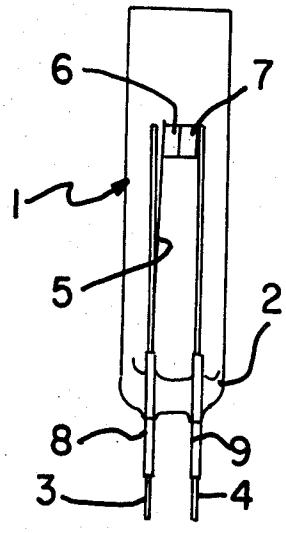
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ABSTRACT: A thermostatic, metallic, snap-acting element and a substantially rigid, electrically conductive post are inserted into an open-ended glass envelope and are then sealed to one end thereof, the element and post being in normal electrical contact. The assembly is then heated to a predetermined temperature and, if the element snaps open, the post is physically displaced to prevent opening thereof at that temperature. The process is repeated at a higher predetermined temperature to ensure opening at the higher temperature. The envelope is then tubulated, filled and sealed.



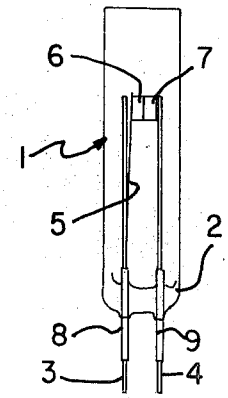


FIG.1

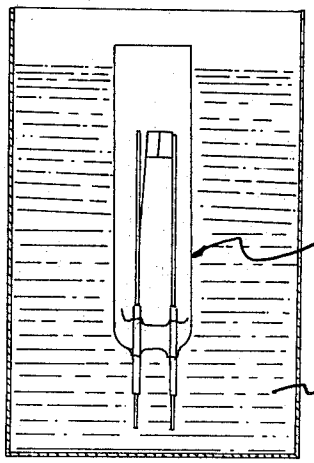


FIG.2

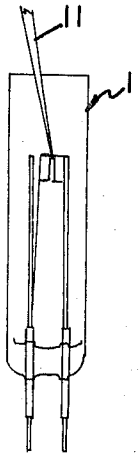


FIG.3

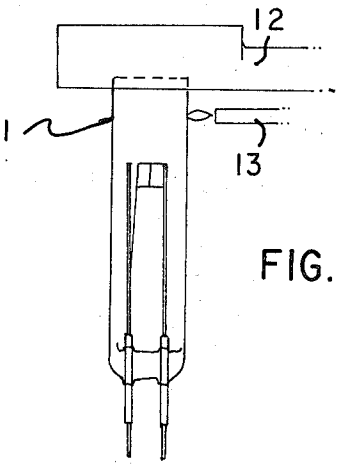


FIG.4

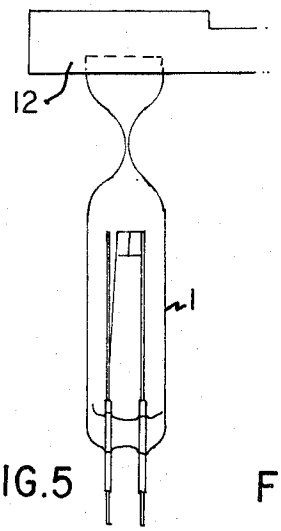


FIG.5

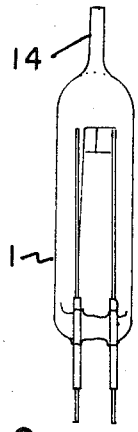


FIG.6

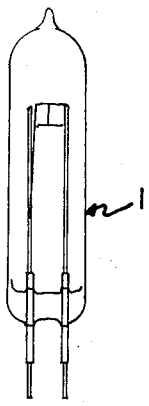


FIG.7

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METHOD OF MAKING A HERMETICALLY SEALED CIRCUIT BREAKER

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention pertains to methods of making hermetically sealed circuit breakers. Circuit breakers are protective devices designed to interrupt an electrical circuit when the control element of the device attains a predetermined temperature, resulting either from current overload or thermal rise.

2. Description of the Prior Art

Snap-action circuit breakers have commonly been encapsulated in metal or glass containers. The process of hermetic sealing such containers usually obviated any adjustment in the calibration or snap temperature of the breaker assembly after the assembly had been enclosed or sealed within the envelope. For example, in a metal enclosed device, the breaker assembly was usually affixed to a glass header prior to insertion into the metal container. The final enclosure was effected by sealing the glass header to the metal container. Occasionally, the calibration temperature was undesirably changed by the heat used in sealing, especially on large circuit breakers rated at more than about 5 or 10 amperes. There was no simple provision for adjusting the calibration of the breaker after the assembly had been secured within the metal envelope.

In glass enclosed devices, the heat required to seal in and support the breaker assembly at the base of the envelope also could change the calibration undesirably. Although some glass enclosed circuit breakers had an exhaust tube at one end of the envelope for the purpose of exhausting, filling and sealing the envelope, again, there was no convenient means for adjusting the calibration of the breaker assembly after it had been secured within the envelope.

SUMMARY OF THE INVENTION

I have discovered a method of making hermetically sealed, glass-enclosed circuit breakers which permits a simple adjustment of the calibration of the breaker assembly after it has been secured within a glass envelope but prior to the final sealing thereof.

According to this invention, an open-ended glass envelope of predetermined diameter and length is first prepared by, for example, severing said length from a longer length of suitable, commercially available glass tubing. A breaker assembly, comprising a thermostatic snap-action metallic element and a substantially rigid post or lead-in wire, is then inserted into the envelope in an operative relationship, that is, with the snappable end of the element being in normal electrical contact with the lead-in wire. The assembly is then physically secured within the envelope by sealing one end thereof, the supporting members of the assembly being embedded in the seal.

The circuit breaker is then heated to a first predetermined temperature by, for example, careful immersion in a heated oil bath. Of course, no oil is permitted to enter the interior of the envelope through the open end thereof. The predetermined temperature must be within the snapping temperature range of the thermostatic element, which can vary about 40° or 50° C., depending on how it has been effected by the heat of sealing and on how much contact pressure there is between it and the lead-in wire. Also, the first predetermined temperature is usually the minimum temperature of the desired operating temperature range of the finished circuit breaker. For example, if it is desired to manufacture a circuit breaker that will open at a temperature between 100° and 110° C., the first predetermined temperature would be 100° C.

Those breakers which do not open at the first predetermined temperature do not require low-temperature adjustment and are passed on to be heated to a second predetermined temperature, usually the maximum temperature of the desired operating temperature range of the finished circuit breaker, which, in the example above, would be 110° C. However, those circuit breakers which open at the first predetermined temperature are unsatisfactory and require adjustment to bring them within the desired range. Adjustment is effected by physically moving the contact end of the lead-in wire a small distance by, for example, inserting an elongated tool through the open end of the envelope and physically engaging and moving said contact end. I have found that in order to raise the snap temperature of the thermostatic element, the lead-in wire must be moved away from the thermostatic element, thus decreasing the normal contact pressure therebetween.

For those circuit breakers which do not open at the upper temperature limit of the desired range, adjustment is effected by moving the contact end of the lead-in wire toward the thermostatic element, thus increasing the contact pressure therebetween and thereby lowering the calibration or snap temperature of the device.

After the circuit breaker satisfactorily passes the requirements at both temperatures, that is, remains closed at the minimum temperature limit but is open at the maximum temperature limit, the open end of the glass envelope is sealed. Preferably, however, I prefer to restrict or tubulate the open end of the glass envelope in order to permit the envelope to be exhausted and filled. Such operations can be more conveniently carried out through an exhaust tube having a smaller diameter than the envelope. After filling, the tube is tipped off to hermetically seal the envelope.

In an alternate method of manufacturing a circuit breaker according to this invention, the support and lead-in wires of the breaker assembly are not directly sealed or embedded in the glass envelope, but instead are hermetically fastened to, and extend through, hollow metal tubes which have been previously sealed to one end of the envelope. Such a circuit breaker can have a high current rating and is shown in a copending application entitled "Hermetically Sealed Circuit Breaker," filed in Sept., 1968, by Dennis et al., and assigned to the same assignee as the instant application. After the support wires of the breaker assembly have been hermetically connected to said metal tubes, such as by brazing, the remainder of the process is similar to that previously described; namely, heating to the predetermined temperatures, adjusting the snap temperature, if necessary, through the open end of the envelope and, finally, sealing.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is an elevational view of a circuit breaker being manufactured in accordance with this invention, showing the breaker assembly sealed in one end of a glass envelope, the other end being open.

FIG. 2 shows the same breaker being heated to a predetermined temperature in a bath of oil.

FIG. 3 shows one method of physically displacing the lead-in wire to change the snap temperature of the thermostatic snap element. As actually illustrated, the lead-in wire is being displaced away from the thermostatic element which results in an increase of the snap temperature.

FIG. 4 shows the circuit breaker being rotated and heated to form a restricted portion, shown in FIG. 5, which, when the excess glass is removed, leaves a tubulation as shown in FIG. 6.

FIG. 7 shows the hermetically sealed circuit breaker, after the tube has been tipped off.

DESCRIPTION OF THE PREFERRED EMBODIMENT

In one example of a circuit breaker manufactured in accordance with this invention, envelope 1 was initially 2½ inches long and was severed from a 4-foot length of 9/16-inch diameter commercially available hard glass tubing. One end of envelope 1 was then heated to its softening point and hermetically press sealed around metal tubes 8 and 9, as shown in FIG. 1. Metal tubes 8 and 9 were made of Kovar, a metal that is sealable to glass, and were hollow. In addition, tubes 8 and 9 extended inwardly and outwardly beyond press seal 2.

Lead-in wires 3 and 4 of a breaker assembly were then inserted into the open end of envelope 1 and into and through metal tubes 8 and 9 and were brazed thereto. The internal portion of the breaker assembly comprised thermostatic snap element 5 attached to lead-in wire 3 and contact buttons 6 and 7 attached respectively to the upper ends of element 5 and lead-in wire 4. Contact buttons 6 and 7 were in normal electrical contact with each other and were about 1 inch from the open end of envelope 1. This extra envelope length provided the requisite amount of glass for the eventual tubulation of the envelope. In addition, as shown in FIG. 2, it permitted the open envelope to be inserted into a hot liquid sufficiently to effectively heat the breaker assembly without permitting the liquid to enter through the open end of the envelope.

The first liquid in which the open ended device was inserted was a bath 10 of oil maintained at a temperature 100° C., this being the minimum temperature of the desired operating range of 100° to 110° C. for the finished circuit breaker. For efficient transfer of heat from the oil to the breaker assembly, the device was inserted into the oil to a point about midway between the upper end of the breaker assembly and the open end of the envelope.

After the breaker envelope reached a temperature of 100° C., it was examined to see if contact buttons 6 and 7 had opened. If so, the opening temperature was raised by bending the upper end of the lead-in wire 4 away from contact button 6. This was effected by inserting a long tool 11, such as a screwdriver, into the open end of envelope 1, physically engaging the upper end of lead-in wire 4 and moving it slightly away from contact button 6. The device was then reheated to 100° C. to determine that the contacts remained closed at that temperature.

The device was next inserted in a similar bath maintained at 110° C., the upper limit of the desired operating range. If the contacts failed to open at that temperature, lead-in wire 4 was displaced, as before, but in a direction toward the contact button 6, as shown in FIG. 3.

After final adjustment, the device was again checked at both temperatures to determine that the opening temperature was between 100° and 110° C.

The open end of envelope 1 was then clamped vertically in a rotatable chuck 12 and, while the envelope was being rotated, a hot flame 13 was directed at a point on the glass envelope about one-fourth inch above the top of the breaker assembly, as shown in FIG. 4. When the glass reached its softening point, the weight of the device stretched the softened glass sufficiently to form a tubulated or necked down portion having a smaller diameter, as shown in FIG. 5. After cooling, the excess glass was cut off, to leave tubulated portion 14 extending from the top of envelope 1, as shown in FIG. 6. In the example described, tube 14 had a diameter of about five thirty-seconds inch.

By means of vacuum rubber tubing inserted onto tube 14, envelope 1 was exhausted and filled with nitrogen. Tube 14 was then tipped off to hermetically seal the envelope, as shown in FIG. 7.

In the adjustment of the snapping temperature of element 5, said temperature is raised by moving lead-in wire 4 away from contact button 6, as mentioned before, to decrease the contact pressure between buttons 6 and 7. The decrease in pressure results in an increase in the snapping temperature of the element.

In the example mentioned above, the rate of change of the snapping temperature is proportional, although not necessarily linearly, to the displacement of contact button 7. In one case, where element 5 was 0.942 inches long, a displacement of 8 mils towards button 6 resulted in a decrease of 6° C. in the snapping temperature of element 5. And a displacement of 10 mils away from button 6 resulted in an increase of 10° C.

In another case, where element 5 was 0.742 inches long, a displacement of 10 mils towards button 6 resulted in a decrease of 13° C. in the snapping temperature of element 5. And a displacement of 10 mils away from button 6 resulted in an increase of 18° C.

For the purposes of this invention, it is immaterial whether the circuit breaker is first heated to the lower or upper temperature limit, although it may be more convenient to test it first at the lower limit. For example, it may be found that for a particular type of circuit breaker, the opening temperature is always near or below the minimum temperature limit and only slight adjustment may be necessary to raise it to within the desired range. In such a case, it may be necessary to test the circuit breaker at the upper temperature. Or the converse may be true, where the opening temperature may always be at or above the maximum temperature limit, in which case, testing at the lower temperature may be unnecessary.

I claim:

1. In the process of manufacturing a glass enclosed hermetically sealed thermostatic circuit breaker, the steps which comprise: inserting a thermostatic circuit breaker assembly including lead-in wires, a snappable contact and a stationary contact, said contacts being normally closed, into an open-ended glass envelope; hermetically sealing by glass to metal seal the lead-in wires of said assembly in one end of said envelope; heating said envelope and assembly, one end of said envelope being open, by immersing in a heated liquid bath to determine whether said contacts open within a predetermined temperature range; varying the contact pressure between said contacts, if said contacts fail to open within said predetermined temperatures range by physical displacement thereof by means of an elongated tool inserted and removed through said open end of said envelope; and sealing the open end of said envelope.

2. The process of claim 1 wherein said contact pressure is varied by moving said stationary contact toward said snappable contact if said contacts fail to open at the upper limit of said predetermined temperature range.

3. The process of claim 1 wherein said contact pressure is varied by moving said stationary contact away from said snappable contact if said contacts open at the lower limit of said predetermined temperature range.

4. The process of claim 1, 2 or 3 including the step of tubulating the open end of said envelope, after determination that said contacts open within said predetermined temperature range but prior to sealing the open end of said envelope.

5. The process of claim 1 including the steps of tubulating the open end of said envelope, after determination that said contacts open within said predetermined temperature range but prior to sealing the open end of said envelope and exhausting and filling said envelope by means of said tubulation and sealing said tubulation.

6. The process of claim 2 including the steps of tubulating the open end of said envelope, after determination that said contacts open within said predetermined temperature range but prior to sealing the open end of said envelope and exhausting and filling said envelope by means of said tabulation and sealing said tubulation.

7. The process of claim 3 including the steps of tubulating the open end of said envelope, after determination that said contacts open within said predetermined temperature range but prior to sealing the open end of said envelope and exhausting and filling said envelope by means of said tubulation and sealing said tubulation.